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ADP/4001526-0008

2. Patent application number
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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

DWIGHT CAVENDISH SYSTEMS LIMITED
THE ICON
LYTTON WAY
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HERTFORDSHIRE SG1 1AH

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

ENGLAND 8634784001

4. Title of the invention

DIGITAL PROCESSING DISRUPTION SYSTEMS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

MILLS & REEVE
FRANCIS HOUSE
112 HILLS ROAD
CAMBRIDGE
CB2 1PH

Patents ADP number *(if you know it)*

6760433001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
N/A		

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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
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YES

INVENTOR IS BAOLIN TAN
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Drawing(s)	2 only 4

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Translations of priority documents	
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Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature FOR AND ON BEHALF OF MILLS & REEVE Date 05.06.03

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ALASDAIR POORE
01223 222248

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CONFIDENTIAL AND PRIVILEGED

Digital processing disruption systems

The present invention relates to methods of disrupting the processing of video signals, so as to inhibit copying, and to systems for counteracting such disruption methods.

It is well known that films and other material ("video material") distributed on video tape are subject to further copying onto video tape, much of which is in breach of the rights owners' rights. Similarly, other films and material distributed by other means such as by direct broadcast or cable, are sometimes copied onto video tape.

As a result technologies have been developed which modify the video signal which is recorded on the original video tape, or is otherwise distributed, in a way which interferes with the normal operation of a standard video recorder so that copies made of such modified video signals cannot be played, or the viewability of such recorded video signals is impaired. One well known such technology is licensed by Macrovision Corporation.

Recently, digital technology has become available for distribution of video material. Concerns have been expressed that such material is of much higher quality and thus that much higher quality copies may be made. In addition, it is now possible to make digital copies of video material intended for viewing on television or similar apparatus, and, once made, these can be further reproduced with little degradation in quality. It has been found that the existing copy protection processes, such as that most commonly licensed by Macrovision, are not effective, at least in some circumstances, to prevent digital copying of analog video signals. There is therefore a need for further copy protection technology to impair copying of video material in digital form.

The present invention provides a method of modifying a video signal in a manner which impairs its conversion by an analog to digital converter system to a form for recording. As is well known, a conventional analog video signal includes several

components. One of these components is a pulse which is designed to identify the point at which the end of one line of active video occurs, and the next starts (at which point the television set executes a horizontal retrace). This pulse is known as a horizontal synchronisation pulse. Immediately prior to the horizontal synchronisation pulse, there is a region known as the front porch, and immediately after the horizontal synchronisation pulse there is a region known as the back porch. The latter extends from the horizontal synchronisation pulse to the beginning of the active video – the point at which the picture information starts for the next line.

According to the present invention there is provided a modified video signal in which the amplitude of the horizontal sync pulse is altered, either by increasing its amplitude over at least part of the duration of the pulse, or reducing its amplitude over at least part of the duration of the pulse, and/or in which the level of the signal in at least part of the back porch is altered, such that the signal when viewed on a standard television shows an image of acceptable viewability, but, when applied to a video capture system either it cannot be properly converted or it is converted to a digital signal which cannot be played or which, when played, shows an image which is not of acceptable viewability. (The alterations to the video signal in the modified video signal are referred to below as "disruption components").

There is further provided in accordance with the invention a method of disrupting the correct processing of a video signal by a video capture system, comprising applying the modified signal to the input of a video capture system, the video signal having been modified to include one or more disruption components.

The term "video capture system" is used to refer to the system which converts the analog video signal to a digital signal which usually can be recorded, or can be otherwise processed in the digital processing equipment, including an analog to digital conversion device. Such devices are used in video capture cards, systems such as the TIVO system, and DVD recorders. Preferably the modified video signal is such that it has this effect at least on "standard" or commonly used video capture systems currently in use, and in particular those having an analog to digital conversion system which has a sync pulse amplitude responsive gain adjustment means and/or black level adjustment means responsive to the level of the, or part of the, back porch.

As is well known, the ability of television sets of different manufacture to display video signals varies. Thus some television sets are able to display signals which differ from the normal broadcast signal adequately or to an acceptable level of viewability, while others are not able to do so or only display such a signal poorly.

In addition, video capture systems, such as video capture cards, DVD recorders and bespoke recording systems such as "TIVO" systems may vary in their ability to tolerate variations from the broadcast standard signal.

In choosing modifications to a video signal the object is to permit viewing on a "standard" television, or as many sets of different manufacture as possible, and at the same time to impair the "pirateability" of the signal such as by the making of a digital copy using a video capture system. In doing so the user must make a compromise which optimises the degree of digital processing disruption (for example copy protection or conversion impairment) – that is the extent of interference with copying and the number of systems on which interference occurs (referred to generally in this application as "conversion impairment"), against the requirement to ensure that the original signal remains viewable to a reasonably acceptable standard ("viewability") on as many different models of television (or other viewing means which use an analog video input) as possible. In short the user must choose a good balance between impairing pirateability and maintaining viewability.

Accordingly a further aspect of the invention is a method of choosing the parameters for such a signal, comprising evaluating the impact of the aforesaid components in a number of video capture systems and choosing the relevant parameters.

Preferably the process of choosing the parameters (referred to below as a "conversion impairment parameter optimisation process") also comprises evaluating the impact of the disruption components on television sets or other television or analog video signal viewing equipment (referred to as "television viewing equipment"), and choosing parameters which permit the modified video signal to be viewed on such equipment to an acceptable level of viewability.

Preferably such conversion impairment parameter optimisation process is carried out in relation to a plurality of video capture systems and a plurality of television viewing equipment.

Preferably the conversion impairment parameter optimisation process involves the steps of applying a modified video signal including disruption components to the input of a video capture system, while monitoring the extent of conversion impairment, and the step of applying the modified video signal to the input of television viewing equipment, while monitoring the viewability of the modified signal, and adjusting the parameters of one or more disruption components, in order to alter the balance between conversion impairment and viewability, preferably to improve the balance, for example by improving conversion impairment while maintaining adequate viewability.

Preferably such process involves applying the modified video signal to a plurality of designs of video capture systems and/or of television viewing equipment, preferably a representative sample of such systems and equipment in the market or being used by those receiving the protected video signals.

In certain cases video capture systems may not be affected by the disruption components to a material degree and in such case such video capture systems may be excluded from such testing. Likewise certain television viewing equipment may not reach an acceptable standard of viewability and may for that reason be excluded from testing.

The tests are preferably carried out using known means for determining acceptable viewability and unacceptable impairment, such as by panels of representative viewers or by persons skilled in determining whether an image is viewable or unacceptably impaired.

The parameters of the disruption components which may be varied during the tests may include the duration of the signal comprising the disruption component, the magnitude of the signal and its location, as well as the rate of change of each of the foregoing parameters, for example if the magnitude of the signal is increased and

decreased in a stepwise or continuous manner.

There is further provided in accordance with the invention a modified video signal with disruption components, at least some of the characteristics of the disruption components having been determined during or following a conversion impairment optimisation process.

Such a modified signal may be recorded on tape or other medium such as DVD or CD, including in a digital format, or may form part of a broadcast signal (which term is used to include video-on-demand), or may be introduced at the point of use by the user, for example in a system which decodes an incoming signal, for example a digital signal, and provides an analog output for use, for example, by a standard analog input television set.

The invention further provides a processing system for processing a video signal to produce an analog output, which modifies the signal so as to include one or more disruption components.

Such systems may be provided for example to consumers, in the form of set top boxes or the like. In such a case, the system may be adjustable so as to optimise viewability for the particular television viewing equipment used by that consumer while ensuring an optimal level of conversion impairment. The invention further provides for a system holding data comprising information about the parameter optimisation for a representative set of television viewing equipment and video capture systems, and may further provide means for remotely setting the parameters in accordance with the information in the data holding system and information provided by the user.

Such systems may further be switchable remotely, so that only certain programme material is modified by the inclusion of disruption components, while other material may be left unmodified so that the user can make acceptable copies of it.

Preferably, in the disruption component in which the amplitude of the horizontal sync pulse is altered, the signal may be modified by reducing the (absolute) amplitude of the sync pulse tip. In accordance with broadcast standards applicable to NTSC and

PAL video signals the horizontal sync pulse tip has an amplitude of about –300mV (below the black level, or black clamping level). Preferably, in such a case the sync pulse tip amplitude is altered to a level between –280mV and –150mV, preferably to a level between –250mV and –200mV.

Alternatively the sync pulse tip (absolute) amplitude may be increased. For example the amplitude may be increased to a level of –600mV. Preferably it is increased to a level of between –320mV and –500mV, preferably about –350mV and 450mV.

In either case the increase or decrease in amplitude is for at least part of the duration of the sync pulse. Preferably it is for a duration of about 30 to 100% of the pulse in the case of an increase and 30 to 90% in the case of a decrease, for example for a duration of between 50% and 100% and 50% and 90% respectively of the pulse duration. Preferably the duration is from about 2 to 4 micro seconds, preferably about 3 microseconds. The amplitude decrease or increase may occur at the beginning, in the middle, or at the end of the pulse; however, preferably in the case of a decrease in absolute amplitude it occurs after the beginning of the sync pulse and may continue to the end of the sync pulse.

The alteration in amplitude may occur on each line on which a horizontal synchronisation pulse occurs, or it may occur on only some such lines. If the altered pulses do not occur on every line, they may be clustered, for example they may occur particularly in advance of the vertical blanking interval. Further the alterations may vary from line to line or from one group of lines to another. The alterations may be absent in some fields and present in other fields. For example the increased amplitude alteration may occur on a cluster of lines, followed by the reduced amplitude alteration. There should be sufficient altered lines to ensure an appropriate level of effectiveness.

One effect of the horizontal sync pulse amplitude alterations is to change the brightness of the image on capture by the video capture system. Thus a decreased amplitude alteration results in the image being converted/recorded brighter than the original. In extreme cases this may result in saturation of the image, with the result that areas of the image appear white. The increased amplitude alteration has the effect

that the image is converted/recorded less bright than the original, and may result in significant loss of visible definition in the viewed image. Switching between the increased amplitude alteration and the reduced amplitude alteration can cause an irritating change in brightness of the viewed image, on capture by the video capture system.

Also in accordance with the broadcast standards applicable to NTSC and PAL signals the region after the horizontal sync pulse called the back porch contains information which is designed to enable the television receiver to decipher a video signal correctly. In particular, the mean level of the back porch, or part of it, has a voltage level of 0. This level is used to determine the "black level" of the television receiver, that is the signal level which represents black on the image. In accordance with a further aspect of the invention, in the modified signal the level of the signal in at least part of the back porch is altered up or down from the 0 level. Preferably this is done by the insertion of a positive or negative pulse into the region of the back porch. Preferably the pulse has a (positive or negative) amplitude of between 30 and 200mV, preferably from 50 to 150mV.

Such a pulse may vary in duration, preferably it has a duration of about 250ns to 4μs, preferably 1μs to 4μs, for example around 3μs. The pulse may occur immediately following the horizontal synchronisation pulse, or at a period after the horizontal synchronisation pulse, for example during the colour burst; preferably it occurs during the colour burst or about 4.8μs after the falling (leading) edge of the horizontal sync pulse [in a PAL standard signal].

The horizontal sync pulse alteration and back porch alteration may be used together. Preferably they are used together.

The effects which have been observed when using both modifications include complete loss of the signal by the video capture card, so that no conversion takes place at all, either through very severe break up or pixelation of the image leading to substantial degradation of the recorded image.

These parameters can be adjusted to optimise the impact. In addition, it is possible that they will have some effect on the viewability, and therefore the parameters are chosen so that the viewability is satisfactory.

These modifications appear to differ from modifications used to protect signals from copying on a standard video tape recorder and, in testing the modifications in accordance with the invention or of the specific ranges described, have little impact on the copiability of the modified signals on standard video tape recorders.

When using the expression "modified video signal" in this application, this is not restricted to the situation in which an unmodified signal (for example a broadcast standard signal) is input into modification circuitry in order to add the disruption components, but includes a signal which may be created ab initio. For example, the modified video signal may be created by combining the picture information from one source with standard timing and control information (such as horizontal sync pulses and colour bursts) from another source, and the disruption components from a third source. In another example, the timing and disruption components may be created from one source, and added to the picture information.

Apparatus for creating the modified signal in accordance with the invention can be made in accordance with well known principles by those skilled in the art. For example, in the case of a pre-existing video signal, the signal can be fed into a circuit which identifies the sync pulse (commonly known as a sync separator). A separate circuit which is triggered by the timing information from the sync separator can be used to generate the signals of each of the desired disruption components, at the correct timing for addition to the unmodified video signal, and the generated signals can be added to the unmodified signals, for example through a mixing circuit.

There is also provided a process (a circumvention process) for making acceptable copies (which term is intended to include any acceptable analog to digital conversion) of a video signal including one or more disruption components, comprising reducing the effects of the disruption components to an acceptable level. For example such a process may comprise inserting a signal which cancels or reduces one or more of the disruption components, or by replacing the section of the video signal which has been

modified by the inclusion of the disruption components by a section which is acceptable to the video capture system, or by inserting a signal which is interpreted by video capture system in a manner which cancels the effect of the disruption component, or alternatively by use of a video capture system which is insensitive to the disruption components. Accordingly the invention further provides a process for "copying" a video signal modified in accordance with the present invention, by inputting such a signal into a video capture system which is insensitive to or is designed to be insensitive to one or more of the disruption components. Insensitive means that an acceptable "copy" can be made.

Where the circumvention process comprises the addition of a further signal which cancels signal of the disruption component, this will depend on the nature of the signal of the disruption component. For example, if in the relevant disruption component, the amplitude of the horizontal sync pulse is increased or decreased the method may insert a sync pulse of the correct amplitude or sufficiently correct amplitude, or insert a pulse of the opposite magnitude to the existing alteration to the sync pulse tip, either so as to eliminate the existing alteration (so that the sync pulse now appears unaltered) or to reduce the alteration, or to reverse its effect by a counteracting pulse on the sync tip, for example by inserting a short duration high pulse which is still recognised by the video capture system, but has the opposite polarity to the existing alteration to the sync tip and the opposite effect on the video capture system as the existing disruption component.

If the back porch level is altered, the method may insert a signal at about the 0 level. Alternatively, the method may blank the signal in the region of the back porch and insert a replacement signal conforming to the appropriate standards, or such that the signal can be converted effectively by the video capture system.

The invention is now described by reference to an example and the figures.

Figure 1 illustrates the horizontal blanking interval of a conventional video signal, extending from the end of the active video on the earlier line, to the beginning of the active video on the following line.

Figure 2 shows generally and schematically the modifications in accordance with the invention.

Figure 3 shows a specific example of the modification in accordance with the invention.

Figure 4 show an analogue video signal trace modified by using the method and apparatus.

Figure 5 shows the image when recorded, without the modifications in accordance with the invention.

Figure 6 shows the image when recorded after modification in accordance with the invention.

In figure 1, the trace starts, 1, with the end of the active video, 2, in the line preceding the illustrated horizontal blanking interval. This is followed by the front porch, 3, and the horizontal sync pulse, 4. Following the horizontal sync pulse, the back porch is shown, 5, and in part of the back porch the colour burst, 6. At the end of the trace, the beginning of the active video for the next line is shown. The pulse tip, 7, of the horizontal sync pulse, 4, descends to a level of about –300mV. The level of the signal in the back porch is shown as about 0v. (In some VTR copy protection systems, these levels may be adjusted over part of the back porch).

In Figure 2 a series of modifications are shown by dotted outlines. The increased amplitude alteration is shown as a dotted line, 20, lower than the unmodified level of the sync pulse tip, at a position of about –450mV; the decreased amplitude modification is shown by a dotted line, 10, higher than the unmodified sync pulse tip, 7, at a level of about –200mV. The back porch modification is shown in two versions, a lower version, shown by the lower dotted line, 30, and an upper version shown by the upper dotted line, 40. It should be understood that the dotted lines show the signal when the relevant modification is present. The diagrams are intended to be schematic and not to a uniform scale.

Figure 3 shows a specific example of the modification, using the same numerals as above. It can be seen that the decreased amplitude sync pulse modification is in the form of a pulse, 21 which appears on the bottom of the sync pulse, 7, and more or less in the middle of the sync pulse. The amplitude of the sync pulse in the region of the altered amplitude is about –200mV. In experiments we have found that a level between 60 to 85 mV above the sync pulse tip produces good results, as does a level of 70 to 110mV below the sync pulse tip, in each case with a duration of about 3μs, in relation to the DAZZLE video capture card.

Figure 3 also shows the second modification, 40, to the back porch. This is in the form of a pulse, 41, inserted shortly after the end of the horizontal sync pulse, 42. The pulse appears in the colour burst, 6, and the oscillation of the colour burst can be seen on top, 43, of the pulse. For example we have found that a pulse of 70 to 120mV or –60 to –80mV produces effective results on the Dazzler video capture card, with an optimum pulse position of the leading edge of the pulse 4.8μs after the leading edge of the sync pulse and duration of 3.3μs.

In the example a PAL video signal modified in this way was applied to the input of a DAZZLE DV-Bridge external video capture card, which was fed into a PC running PowerDirector software. The modified signal is illustrated in the traces in Figure 4, in this case with a change of amplitude over the full width of the sync pulse and the outcome of this signal (with some small variations) is illustrated in Figures 5 (showing the image recorded of the unmodified signal) and Figures 6 (showing the image recorded from the signal after modification.). The same tests were carried out with other systems and a "TIVO" computer based video recorder with similar results.

When the test was repeated with the DAZZLE Video Capture card using a NTSC standard signal modified in accordance with the invention, the video capture card/capture software stopped operating and no signal was recorded at all.

The specific examples are intended as illustrations of embodiments of the invention and are not intended to limit the scope of the invention. Those skilled in the art will understand that there are many other ways of performing the invention.

Claims:

1. A modified video signal in which the amplitude of the horizontal sync pulse is altered, either by increasing its amplitude over at least part of the duration of the pulse, or by reducing its amplitude over at least part of the duration of the pulse, and/or in which the level of the signal in at least part of the back porch is altered, such that the signal when viewed on a standard television shows an image of acceptable viewability, but, when applied to a video capture system either it cannot be properly converted or it is converted to a digital signal which cannot be played or which, when played, shows an image which is not of acceptable viewability.

2. A modified video signal according to claim 1 in which at least some of the horizontal sync pulses are altered by reducing their amplitude to 280 to 150mV, over at least part of the duration of the pulse.

3. A modified video signal according to any preceding claim in which at least some of the horizontal sync pulses are altered by increasing their amplitude to 320 to 500mV, over at least part of the duration of the pulse.

4. A modified video signal according to any preceding claim in which the duration of the alteration is 30 to 90% of the duration of the horizontal sync pulse.

5. A modified video signal according to any preceding claim in which at least some of the back porches are altered by the presence of a positive or negative pulse of amplitude in the range +30 to 200mV or – 50 to –150mV, and a duration in the range 1 to 4μs.

6. A modified video signal according to any preceding claim in which the leading edge of the pulse is about 4.8μs after the leading edge of the sync pulse.

7. A modified video signal in accordance any of the preceding claims, in which at least some of the characteristics of the alterations have been determined during or

following a conversion impairment optimisation process.

8. A recorded video signal in accordance with any of the preceding claims.

9. A method of processing a video signal in order to create a modified video signal in accordance with any of the preceding claims.

10. An apparatus for processing a video signal in order to create a modified video signal in accordance with any of the preceding claims.

11. An apparatus in accordance with claim 10, in which the characteristics of the alterations can be set remotely.

12. A process for making a copy or otherwise converting a modified video signal according to any of the preceding claims in a video capture system to create an acceptable converted signal, comprising treating the signal in such a way as to circumvent the effect of the alterations to the video signal or by applying the video signal to a video capture system which is not sufficiently responsive to the alterations to the video signal.

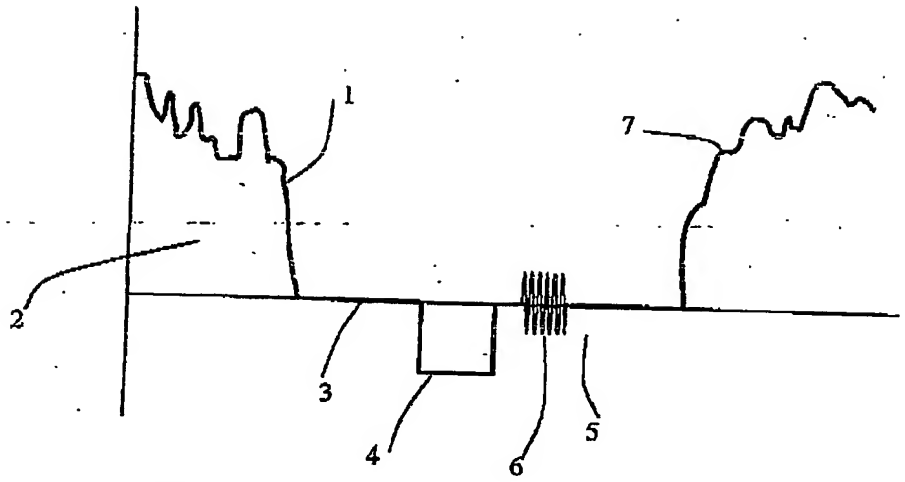

Figure 1

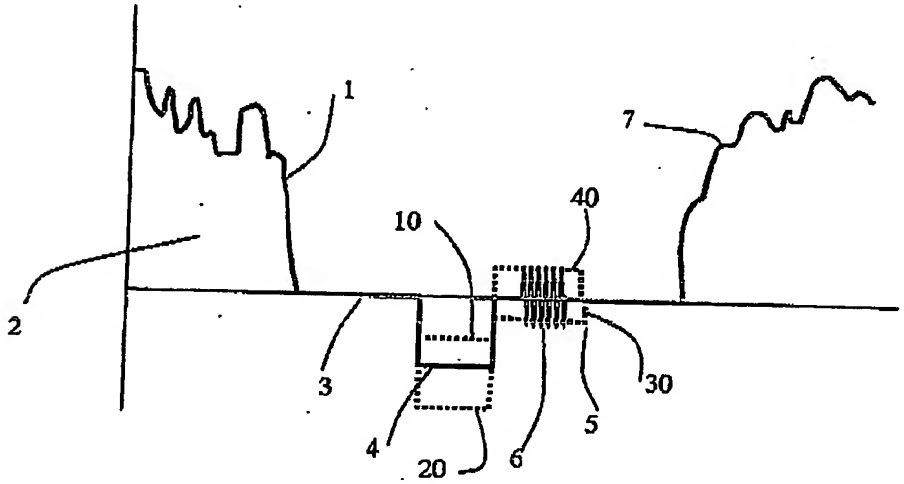

Figure 2

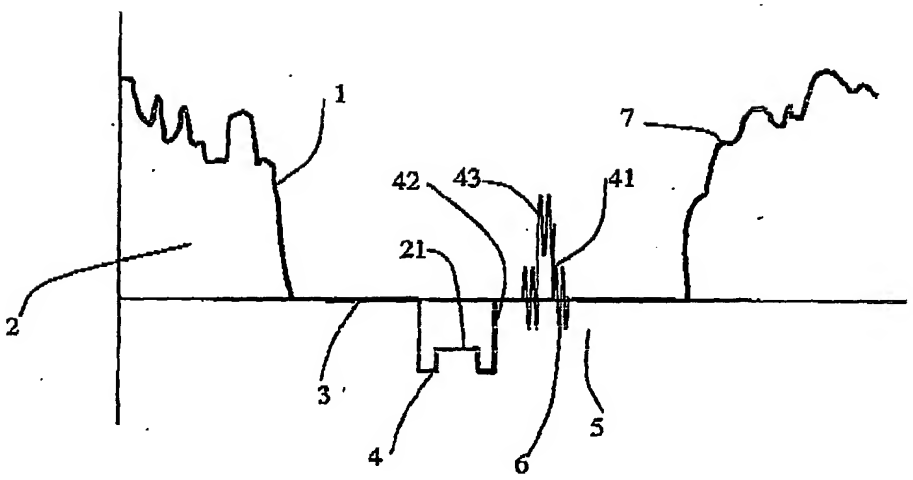

Figure 3

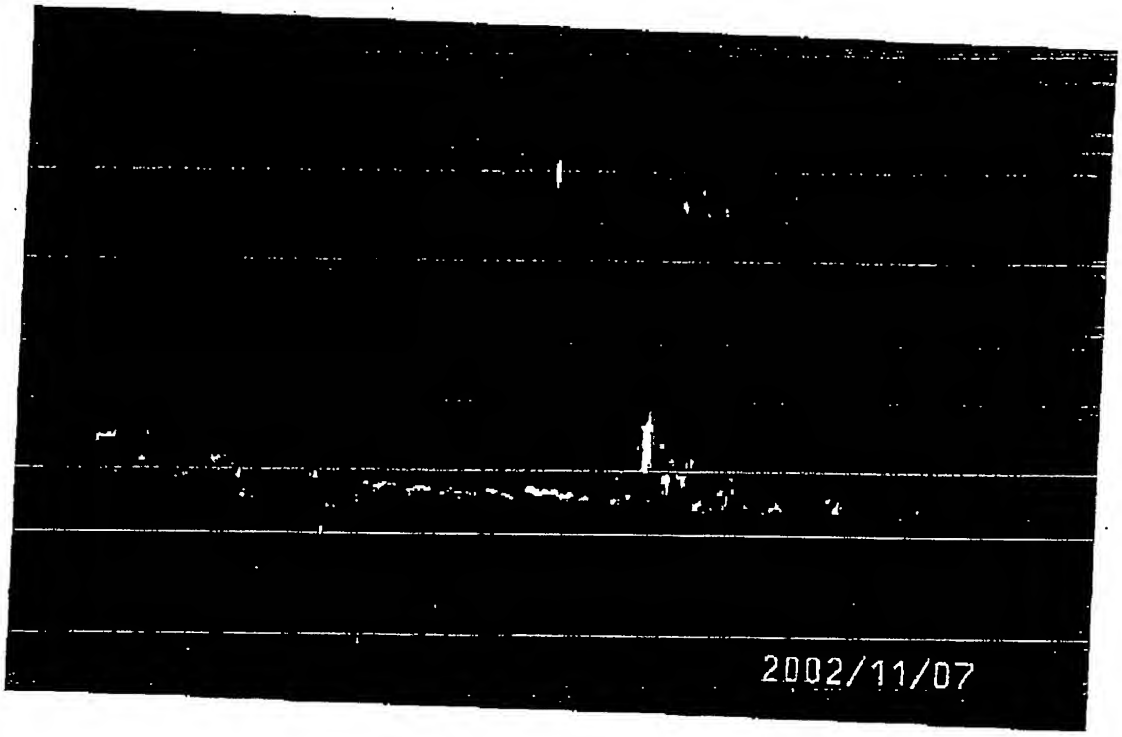

Figure 5

Figure 6

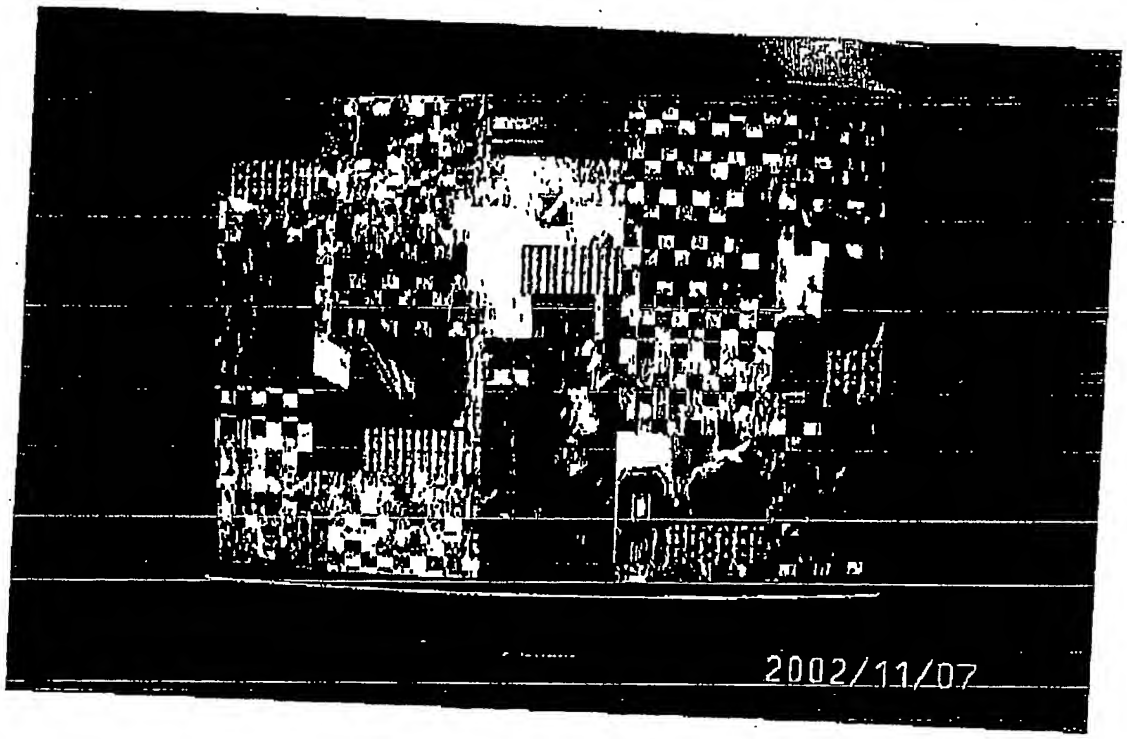

Figure 7